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ABSTRACT

This study explored the effects of different sentence conditions upon reading comprehension as evidenced by reading rate and recall taken at various times. Thirty-two subjects from a California high school representing four sex-by-ability groups, read experimental material on a table-top programmer while being timed. Recall responses were recorded on a cassette tape recorder. Experimental conditions of the trials varied by size of presentation, sentence by sentence or block of three sentences; type of passages, paragraph or unrelated sentences; order of input, logical or scrambled; and recall condition, immediate recall or no immediate recall. Some of the results showed that rate significantly increased in both sentence by sentence reading and immediate recall conditions. Scrambling the order of related sentences increased the time taken to read the material. The more able readers recalled more than the average-ability readers. Sentence by sentence readings significantly increased the number of correct responses. Immediate recall was an important variable, increasing total production, types of responses within and across test points, and amount of recall between test points. Unrelated sentences were remembered more accurately than related ones. (MKM)

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RECALL FOR CONTEXT-RELATED SENTENCES AND FOR SIMILAR UNRELATED SENTENCES

Priscilla Drum
University of Colorado
March 12, 1975

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Recall For Context-Related Sentences And For Similar Unrelated Sentences

Priscilla Drum
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The Research Questions

This study explored the effects of different sentence conditions upon reading comprehension as evidenced by reading rate and recall taken at various points in time. The four experimental questions for this study were the following: (1) In what ways do the amount and type of information recalled change when the sentences are part of a passage rather than a collection of unrelated sentences? Does it take longer to read related sentences than unrelated ones? (2) How much information is recalled from individual sentences when presented one by one versus the amount recalled when the sentences are presented in groups of three sentences? Does one condition require more reading time than the other? (3) Will scrambling the sentences from coherent passages affect recall of information in measurable ways that will not be apparent in logically-ordered passages? Will it take longer to read randomly-ordered sentences? (4) Will immediate recall improve the amount of recall at later recall test points? Also, because of the switching from reading to recitation and back to reading, will the processing time for sentences read under immediate recall conditions be measurably longer?

The factors chosen as the components of the experimental conditions in order to provide information on these questions were these: (1) twelve sentences were presented one by one or in blocks of three sentences each; (2) the sentences were either a group of passage-related ones or a group of unrelated sentences; (3) the sentences were presented in logical order or in scrambled order; and (4) half of the time, immediate recall was taken after the subject processed the individual sentences or blocks of sentences.

The dependent measures were the reading time that the subject took and his recall of information. Reading time for each trial, either twelve single sentences or four blocks of three sentences, was recorded. Three types of recall information were obtained: immediate recall after half of the presentation units, cued recall at the end of each trial of twelve sentences, and delayed recall at the end of each testing session.

Experimental Materials

Syntactically and semantically similar sentences were needed for this study to compare the effects of coherence (related versus unrelated sentences) upon subject recall. Since a reader is in a naive state only

before the first reading of a sentence or a passage, it was also necessary to prepare a number of semantically and syntactically similar materials in order to successively test each subject under the various treatment conditions.

Two base paragraphs were selected: "May Day" (J. Sachs' dissertation, 1966) and "Mare's Milk" (P. Drum's literal comprehension test, 1972). The experimental data on these passages indicate that they are comprehensible and that specialized knowledge is not needed to understand them. By using two different base passages from which to prepare materials, it was also possible to see if any treatment effects would hold over the two types of passages and if any differences between the two types of passages would hold over the materials prepared from each source.

Both paragraphs were edited to twelve sentences each and then examined in detail. For each of the twenty-four sentences, frames were prepared. The frames included the syntactic/semantic information from the analyses and some additional descriptive, school grammar information. Then, the four writers, all college graduates but with no special training for this task, independently from one another, wrote twelve unrelated sentences for each set of frames and a coherent paragraph of twelve sentences for each set of frames. Finally, two, randomly-drawn, scrambling orders, one for each base paragraph, were applied to the eight paragraphs and eight sets of unrelated sentences, resulting in thirty-two sets of twelve sentences derived from two base paragraphs.

Procedures

Subjects. The thirty-two subjects from Carlmont High School, San Mateo, California, represented four sex by ability groups: high-ability males, high-ability females, average-ability males, and average-ability females. The ability designation was determined by class assignment (accelerated or average) and by teacher selection. The subjects' percentile scores on the verbal portion of the Preliminary Scholastic Aptitude Test or the reading comprehension portion of the California Test of Basic Skills or the subtest five "How to interpret reading in the social studies" of the Iowa Test of Educational Development were used as descriptors of the four groups and in first order correlations with the summary measures. Each subject was tested individually in two testing sessions of four trials each with approximately forty-eight hours between each session.

Testing Sessions. A SR-400 table top programmer was used to present all materials. The time taken to read each sentence or block of three sentences was kept by means of a stop watch; the subjects' recall responses were recorded on a Sony Cassette taperecorder. Each subject received four, twelve-sentence trials of passages blocked into four, three-sentence groups and four, twelve-sentence trials of individual sentences. Four of the trials were coherently related sentences, two presented in logical order and two in scrambled order; the other four trials were unrelated sentences, two presented in original order and two in another randomly-drawn order. On four trials, the subject was asked for recall as soon as he had read either a sentence or a block of three sentences; on the other four trials, he was not tested for immediate recall.

At the end of each trial of twelve sentences, the subject was given a cued recall task. A head noun, the semantic or syntactic subject or object of the sentence, was presented for each of the twelve sentences, and the subject was asked to recall all information from the trial that was associated with that word. The order of cues within a trial was balanced by a 12 x 12 latin square and then randomized across subjects. At the end of each session, the experimenter presented the subject with the twelve cue words from each trial, with the order of trials balanced by a 4 x 4 latin square and randomized across subjects. The subject was asked to recall all information from the trial containing the cue words. The experimental conditions embedded within trials and the order of presentation across trials and sessions were balanced by the within portion of the design. A subject's experimental conditions for the eight trials can be seen in Table 2.

Responses. The subjects' responses were analyzed and coded into the following four categories: (1) identity responses--repetition of words that appeared in the original passage; (2) correct synonyms--words that mean the same thing as words in the original passage; (3) deletions--words that appear in the original passage which the subject did not mention; and (4) intrusions--words that did not appear in the original passage that the subject added.

Substantial agreement between two scorers at .95 was obtained on coding of protocols. Scorer 2 randomly selected about one-fourth of the protocols for this purpose. Scorer 1's judgments were used in further analyses of the data.

The recorded times for each presentation unit, sentence or block, were summed for each trial for each subject, and the time per trial became the rate measure used in further analyses.

Design

The between-subjects portion of the design was a one-half fraction of a 2^6 design, which required thirty-two subjects. The confounded blocks portion of the between-subjects design was described as a 2^4 factorial structure for convenience. The within-subjects portion of the design was a one-eighth fraction of a 2^{10} factorial design. This yielded a 2^7 design which was broken into sixteen blocks of eight cells each. The sixteen possible combinations of the four, two-level, R,S, T,U confounded blocks factors provided a balanced sex by ability assignment of subjects to the sixteen blocks of the within-subjects portion of the design, resulting in two subjects per block with the eight cells per block the eight experimental conditions for the eight trials per subject. The experimental factors and the general design structure are summarized in Table 3.

Analyses. An initial analysis of variance was used to determine significant sources by testing against a pooled, residual error term. The significant sources were then subjected to further analyses with appropriate individual error terms. Because of the similarities between the various recall measures, these were then summed and tested against their appropriate error terms. Omega square was also calculated for the significant treatment factors and their relationship to the summed recall measure in order to determine the predictive power afforded by these relationships. Finally, first order correlations for the new summary measures with the subjects' ability scores were also obtained.

Results

Rate. Both sentence-by-sentence reading and the immediate recall condition significantly increased the time taken to read the material. Scrambling the order of related sentences increased the time taken to read the material, which was the only interaction effect for reading rate. Sex was also significant with females generally taking longer to read the material. There was no effect for ability on the rate measure. Table 4 presents the analysis of variance for rate.

Recall. As expected, the more able readers recalled more than the average-ability readers. However, the ability of the subjects did not interact with any of the treatment factors. The relatedness of the sentences, the immediate recall condition, and the size of presentation were also significant on identity responses, deletions, and total production. Sentence-by-sentence reading significantly increased the number of correct responses as well as the amount of total production at all test points. Immediate recall was a very potent variable in that it had a significant, positive effect on total production, on types of responses within and across test points, and on amount of recall between test points. Unrelated sentences were remembered more accurately than related ones. The order of sentences had only a minimal effect on total production though in the expected direction; logically-ordered sentences were recalled better than scrambled sentences. The summary recall results can be seen in Table 5.

Discussion

This study indicates that there are differences for recall between the properties of related sentences and unrelated sentences. There is less total information in each of the related sentences than there is in each of the unrelated sentences. The dependencies between related sentences, such as repetition of words, synonyms, anaphoric references, and the focusing on some aspect of the topic are, in effect, clustering devices which enable the reader to retain most of the major information in one or two chunks. Since, by definition, unrelated sentences are unique unto themselves, though they can have more than one clause, a reader is likely to either recall the sentence almost verbatim or not to recall any of it. If the unrelated sentence has more than one clause,

then the reader seems to recall the material by the clausal structure, generally remembering the main clause if he remembers anything from the particular sentence, but sometimes deleting subsequent clauses. The major parts of the clause appear to be the structural unit used by readers in retaining unrelated sentence information, but there seems to be some other unit used by readers in retaining related sentence information.

For other treatment factors there appears to be a trade-off between rate and recall. Those factors which increased reading time, the sentence-by-sentence reading and the immediate recall condition, also significantly increased the amount of material recalled. By studying each of these factors in other experimental situations, it should be possible to discern which one has a more positive effect on reading effectiveness (recall of information) proportionate to the decrease in reading efficiency (reading rate).

The immediate recall factor is a very interesting variable for educational examination. If simply repeating the sentences after reading them significantly improves recall at later points in time, more active manipulations of the materials while reading such as instructions to paraphrase, to outline the material to formulate questions about the information should have even more of a positive effect on retention.

TABLE 1. Experimental Materials

Derivative Passages from Model A	Derivative Passages from Model B
4 logically ordered paragraphs	4 logically ordered paragraphs
4 scrambled paragraphs	4 scrambled paragraphs
4 unrelated sets of 12 sentences	4 unrelated sets of 12 sentences
4 reordered sets of 12 sentences	4 reordered sets of 12 sentences

TABLE 2. Experimental Conditions of Trials

		Session One				Session Two			
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4
Size of Presentation	Sentence by Sentence		XX		XX	XX		XX	
	Block of Three Sentences	XX		XX			XX		XX
Type of Passage	Paragraph			XX	XX	XX	XX		
	Unrelated Sentences	XX	XX					XX	XX
Order of Input	Logical		XX	XX			XX	XX	
	Scrambled	XX			XX	XX			XX
Recall Condition	Immediate Recall		XX	XX			XX	XX	
	No Immediate Recall	XX			XX	XX			XX

The XX_s in Table 2 indicate the experimental conditions for the eight trials for a single subject.

TABLE 3. Variables in the Between-Subjects and the Within-Subjects Portions of the Design

Type of Variable	Variables	Code Letters	Levels
Between-Subjects			
Subject Classification	Sex	X	2
Subject Classification	Ability	W	2
Control	Counfounded Blocks	R, S, T, U	16
Within-Subjects			
Materials	Model Paragraphs	B	2
Materials	Writers	E,F	4
Materials	Coherence	A	2
Presentation	Presentation Size	C	2
Presentation	Immediate Recall	J	2
Presentation	Order of Sentences	K	2
Control	Sessions	D	2
Control	Trials	G,H	4

TABLE 4

ANALYSIS OF VARIANCE: RATE MEASURE FOR MAIN EFFECTS AND SIGNIFICANT INTERACTIONS

	FULL DESIGN: CUED AND DELAYED RECALL				ONE-HALF DESIGN: IMMEDIATE RECALL			
BETWEEN SOURCES	MEANS	df_1/df_2	MS(E)	F	MEANS	df_1/df_2	MS(E)	F
Sex Male/Female	87.6.102.9	1,14	1,701.4	8.8**	99.4/108.4	1,14	1,046.3	8.8**
Ability High/Average	94.2/96.3	1,14	1,701.4	< 1	98.3/101.6	1,14	1,046.3	< 1
Sex by Ability		1,14	1,701.4	< 1		1,14	1,046.3	< 1
Block Residuals		14,14	1,701.4	4.9**		14,14	1,046.3	5.4*
TREATMENTS WITHIN SOURCES								
Coherence Related/Unrelated Sentences	95.7/94.8	1,26	197.3	< 1	100.7/99.2	1,28	202.5	< 1
Base Paragraphs Model A/Model B	95.8/94.7	1,28	231.1	< 1	100.3/99.5	1,28	159.1	< 1
Presentation Size Single Sentence/ Three Sentences	101.0/89.5	1,26	170.0	50.0**	105.1/94.8	1,28	202.5	16.9**
Immediate Recall Immediate Recall/ No Immediate Recall	99.9/90.6	1,24	200.5	28.0**				
Order of Sentences Logical/Scrambled		1,24	200.5	< 1				
Coherence by Order of Sentences		1,26	170.0	5.4*				

*p > .05 F = 4.26 df = 1,24
**p > .01 F = 7.82 df = 1,24

TABLE 5

ANALYSIS OF VARIANCE: SUMMARY RECALL OF PRODUCTIVE RESPONSES FOR ALL MAIN EFFECTS AND SIGNIFICANT TWO- AND THREE-WAY SOURCES

	FULL DESIGN: CUED AND DELAYED RECALL					ONE-HALF DESIGN: IMMEDIATE RECALL				
BETWEEN SOURCES	MEANS	df_1/df_2	MS(E)	F	w^2	MEANS	df_1/df_2	MS(E)	F	w^2
Sex Male/Female	15.0/14.3	1,14	88.9	< 2	.003	21.5/19.8	1,14	89.6	3.4	.03
Ability High/Average	16.8/12.5	1,14	88.9	79.0**	.37	21.5/17.8	1,14	89.6	35.4**	.42
Sex by Ability		1,14	88.9	10.5**	.04		1,14	89.6	3.8	.03
Block Residuals		14,14	88.9	< 2	.34		14,14	89.6	< 2	.14
TREATMENT WITHIN SOURCES	MEANS	df_1/df_2	MS(E)	F	w^2	MEANS	df_1/df_2	MS(E)	F	w^2
Coherence Related/Unrelated	13.4/15.9	1,26	64.9	36.3**	.13	19.8/21.5	1,28	37.4	6.9*	.02
Base Paragraphs Model A/Model B	15.4/13.9	1,28	52.6	15.5**	.04	20.8/20.5	1,28	14.3	< 1	.005
Presentation Size One/Three	15.3/14.0	1,26	33.6	22.3**	.04	25.5/15.8	1,28	37.4	237.8**	.80
Immediate Recall With/Without	15.5/13.8	1,24	46.8	21.8**	.06					
Order of Sentences Logical/Scrambled	15.1/14.2	1,24	46.8	5.9*	.01					
Writers		3,158	39.5	21.5**	.14					
Experimental Order		7,158	39.5	< 2	.00					
Coherence by Base Paragraphs		1,28	36.9	11.7**	.02					
Coherence by Presentation Size		1,24	46.8	8.6**	.02					
Coherence by Immediate Recall		1,26	33.6	9.6**	.02					

TYPES OF RESPONSE (M) MIXED SOURCES	MEANS	df_1/df_2	MS(E)	F	w^2	MEANS	df_1/df_2	MS(E)	F	w^2
Types of Response (M) Identity/Synonyms/ Intrusions	32.3/7.9/3.8	2,56	188.4	644.1**	.93	49.5/9.8/2.6	2,56	117.0	695.9**	.94
Sex by M		2,56	188.4	< 1	.00		2,56	117.0	< 1	.00
Ability by M		2,56	188.4	14.3**	.02		2,56	117.0	22.5**	.03
Sex by Ability by M		2,56	188.4	2.8	.00		2,56	117.0	6.1*	.01
Block Residuals by M		28,56	188.4	< 2	.00		28,56	117.0	< 2	.01

TYPES OF RESPONSE (M) BY TREATMENTS WITHIN SOURCES	df_1/df_2	MS(E)	F	w^2	df_1/df_2	MS(E)	F	w^2
Coherence by M	2,52	50.7	47.6**	.18	2,56	32.8	18.8**	.05
Base Paragraphs by M	2,56	64.9	2.0	.01	2,56	34.1	< 2	.00
Presentation Size by M	2,52	26.2	21.1**	.04	2,56	32.8	265.6**	.72
Immediate Recall by M	2,48	26.9	28.4	.06				
Order of Sentences by M	2,48	26.9	< 2	.00				
Writers by M	6,316	32.2	10.8**	.07				
Coherence by Base Paragraphs by M	2,56	36.3	5.3**	.01				
Coherence by Presentation Size by M	2,48	26.9	7.8**	.01				
Coherence by Immediate Recall by M	2,52	26.2	6.0**	.01				

TEST POINTS (Z) MIXED SOURCES	MEANS	df_1/df_2	MS(E)	F	w^2	MEANS
Text Points (Z) Cued/Delayed	15.5/13.8	1,28	13.6	83.8**	.71	20.6
Sex by Z		1,28	13.6	4.6	.03	
Ability by Z		1,28	13.6	< 2	.00	
Sex by Ability by Z		1,28	13.6	< 1	.01	
Block Residuals by Z		14,28	13.6	< 2	.01	

TEST POINTS (Z) BY TREATMENTS WITHIN SOURCES	df_1/df_2	MS(E)	F	w^2
Coherence by Z	1,26	5.3	22.6**	.09
Base Paragraphs by Z	1,28	7.3	< 2	.00
Presentation Size by Z	1,26	3.1	< 2	.00
Immediate Recall by Z	1,24	5.6	5.6*	.02
Order of Sentences by Z	1,24	5.6	< 1	.00
Base Paragraphs by Presentation Size by Z	1,28	4.9	6.7*	.02
TEST POINTS (Z) BY TYPES OF RESPONSE (M) MIXED SOURCES	df_1/df_2	MS(E)	F	w^2
Z by M	2,56	6.2	31.8**	.73
Sex by Z by M	2,56	6.2	< 2	.01
Ability by Z by M	2,56	6.2	2.6	.02
Sex by Ability by Z by M	2,56	6.2	< 1	.00
Block Residuals by Z by M	28,56	6.2	< 2	.01
TEST POINTS (Z) BY TYPES OF RESPONSE (M) BY TREATMENTS WITHIN SOURCES	df_1/df_2	MS(E)	F	w^2
Coherence by Z by M	2,56	5.6	2.3	.01
Base Paragraphs by Z by M	2,56	3.2	< 1	.00
Presentation Size by Z by M	2,56	3.9	< 2	.00
Immediate Recall by Z by M	2,56	2.9	8.9**	.02
Order of Sentences by Z by M	2,56	2.9	3.8*	.01

*p > .05 F = 4.26 df = 1,24; F = 3.23 df = 2,40.
**p > .01 F = 7.82 df = 1,24; F = 5.18 df = 2,40.